An Assessment of the Fa
Vedder-Chilliwack River S[illegible]rt Fishery, 1986

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AN ASSESSMENT OF THE FALL VEDDER-CHILLIWACK RIVER SPORT FISHERY, 1986

by

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ABSTRACT

Whyte, I.W., N.D. Schubert and D.G. Hickey. 1987. An assessment of the fall Vedder-Chilliwack River sport fishery, 1986. Can. MS Rep. Fish. Aquat. Sci. 1928: 22p.

Each fall, the Vedder-Chilliwack River supports a major coho salmon sport fishery. Hatchery production of 1983 brood coho (all marked with a pelvic fin clip) increased substantially from the previous year. Unlike previous years, adult returns from hatchery production were expected to constitute a major part of the 1986 return. This study assessed the angler effort and harvest in the Vedder-Chilliwack River from September 1, 1986 to January 31, 1987.

Angler effort and coho harvest increased substantially from 1985 when a similar study was undertaken. Above Highway 1, angler effort was estimated at approximately 142,500 angler hours, peaking in October at 46,400 angler hours. Estimated harvest above Highway 1 included 15,279 coho salmon (14,699 adults and 580 jacks), 398 chinook salmon (246 adults and 152 jacks), 28 Dolly Varden char, 18 rainbow trout and 961 steelhead trout. Released steelhead trout were estimated at 1,148 fish. An additional 23,900 angler hours of effort were estimated for the river below Highway 1.

Marked coho salmon accounted for 87.3% of the adult harvest and 2.4% of the coho jack harvest. Right pelvic fin clipped coho accounted for 83.8% of the adult harvest.

Key Words: sport fishery, Vedder-Chilliwack River, catch, angler effort, coho salmon.

RÉSUMÉ

Whyte, I.W., N.D. Schubert and D.G. Hickey. 1987. An assessment of the Vedder-Chilliwack River sport fishery, 1986. Can. MS Rep. Fish. Aquat. Sci. 1928: 22p.

Chaque automne, le stock de saumon coho des rivières Vedder-Chilliwack fait l'objet d'une intense pêche sportive. La production de cohos d'elévage en 1983 (tous marqués par rognage de la nageoire pelvienne) a nettement augmenté par rapport à l'année précédente. Contrairement à 1985, on s'attendait à ce que les remontées d'adultes issus de ces lâchers constituent un important pourcentage de la remontée de 1986. La présente étude vise l'évaluation de l'effort de pêche sportive et du nombre de saumons capturés dans les rivières Vedder-Chilliwack du 1er septembre 1986 au 31 janvier 1987.

L'effort de pêche sportive et le nombre de cohos capturés ont nettement augmenté par rapport à 1985. En amont de la route 1, on estime que l'effort se situe à eniron 142 500 heures de pêche sportive, avec une pointe de 46 400 en octobre. Les captures estimatives comprennent 15 279 cohos (14 699 adultes et 580 jeunes mâles précoces), 398 quinnats (246 adultes et 152 jeunes mâles précoces), 28 Dolly Varden, 18 truites arc-en-ceil et 961 truites arc-en-ceil anadromes. Le nombre estimatif de truites arc-en-ceil anadromes relâchées se situe à 1 148 poissons. En aval de la route 1, on estime que l'effort de pêche sportive se chirre à 23 900 herues.

Les saumons cohos marqués représentaient 87,3% des adultes amontants et 2,4% des jeunes mâles précoces amontants tandis que les cohos dont la nageoire pelvienne droite avait été rognée constituaient 83,8% des adultes amontants.

Mots-cles: pêche sportive, rivières Vedder-Chilliwack, prises, effort de pêche sportive, saumon coho

INTRODUCTION

The Vedder-Chilliwack River supports one of British Columbia's largest nontidal sport fisheries. The fall fishery for coho salmon (**Oncorhynchus kisutch**) was assessed by a preliminary study in 1984 (DPA Group Inc. MS 1985) and by a more detailed study in 1985 (Hickey **et al.** 1987). The current study continues that assessment for 1986.

The fall sport fishery was surveyed for three reasons. First, the sport fishery catch of hatchery coho adults was expected to be several times the 1985 level. The 1986 study, therefore, provided an opportunity to evaluate effort and catch per unit effort (CPUE) responses associated with large changes in fish abundance. Second, most 1983 brood hatchery production was marked with a fin clip. The 1985 study assessed the catch of precocious males (jacks) from that brood; the 1986 study completed that assessment for adults. Third, the retention of chinook adults (O. **tshawytscha**) was permitted in the Vedder-Chilliwack River for the third consecutive year, from September 5 to November 30, 1986. The 1986 study provided an assessment of that fishery.

This report describes the study design and field procedures and documents the results of the 1986 Vedder-Chilliwack River sport fishery survey. Presented are monthly estimates of angler effort, harvest and release by species and mark type, and angler characteristics. The report concludes with an evaluation of changes in the sport fishery relative to 1985.

STUDY AREA DESCRIPTION

The Vedder-Chilliwack River arises in the Cascade Mountains of Washington State. The river flows north across the Canada/U.S.A. border, draining into Chilliwack Lake, then continues in a westerly direction for 61 kilometers, entering the Sumas River and subsequently the Fraser River near Chilliwack, B.C. (Fig. 1).

The study area was stratified into four regions, as described by Hickey **et al.** (1987)(Fig. 1). Region 1 extended from the Fraser River to Highway 1 (km 4), including portions of the Sumas and Vedder rivers. Region 2 extended from Highway 1 to the bridge at Vedder Crossing (km 16). Region 3 extended from Vedder Crossing to the Tamihi Creek Bridge (km 26), and Region 4 extended from the Tamihi Creek Bridge to the mouth of Slesse Creek (km 34).

1986 FISHERY REGULATIONS

The 1986 fall sport fishery was managed through area closures, size limits and species-specific daily and annual catch limits (Ministry of Environment 1986). Salmon regulations permitted the retention of coho and chinook only; the retention of sockeye (O. **nerka**), pink (O. **gorbuscha**) and chum (O. **keta**) was not permitted. The daily salmon catch was limited to four, of which a maximum of four coho and only one chinook could be larger than 50 cm (nose to fork of tail: FL). The annual catch limit for chinook salmon was ten, and the minimum size limit for all salmon was 30 cm FL.

Trout regulations permitted a daily catch of two (except a daily catch of up to four hatchery rainbow trout over 20 cm FL was permitted), of which up to two could be cutthroat (**Salmo clarki**) over 30 cm FL and one could be an adipose clipped (hatchery) steelhead (S. **gairdneri**). The annual catch limit of hatchery steelhead was ten.

In addition to the above, the Chilliwack River from Slesse Creek upstream to the outlet of Chilliwack

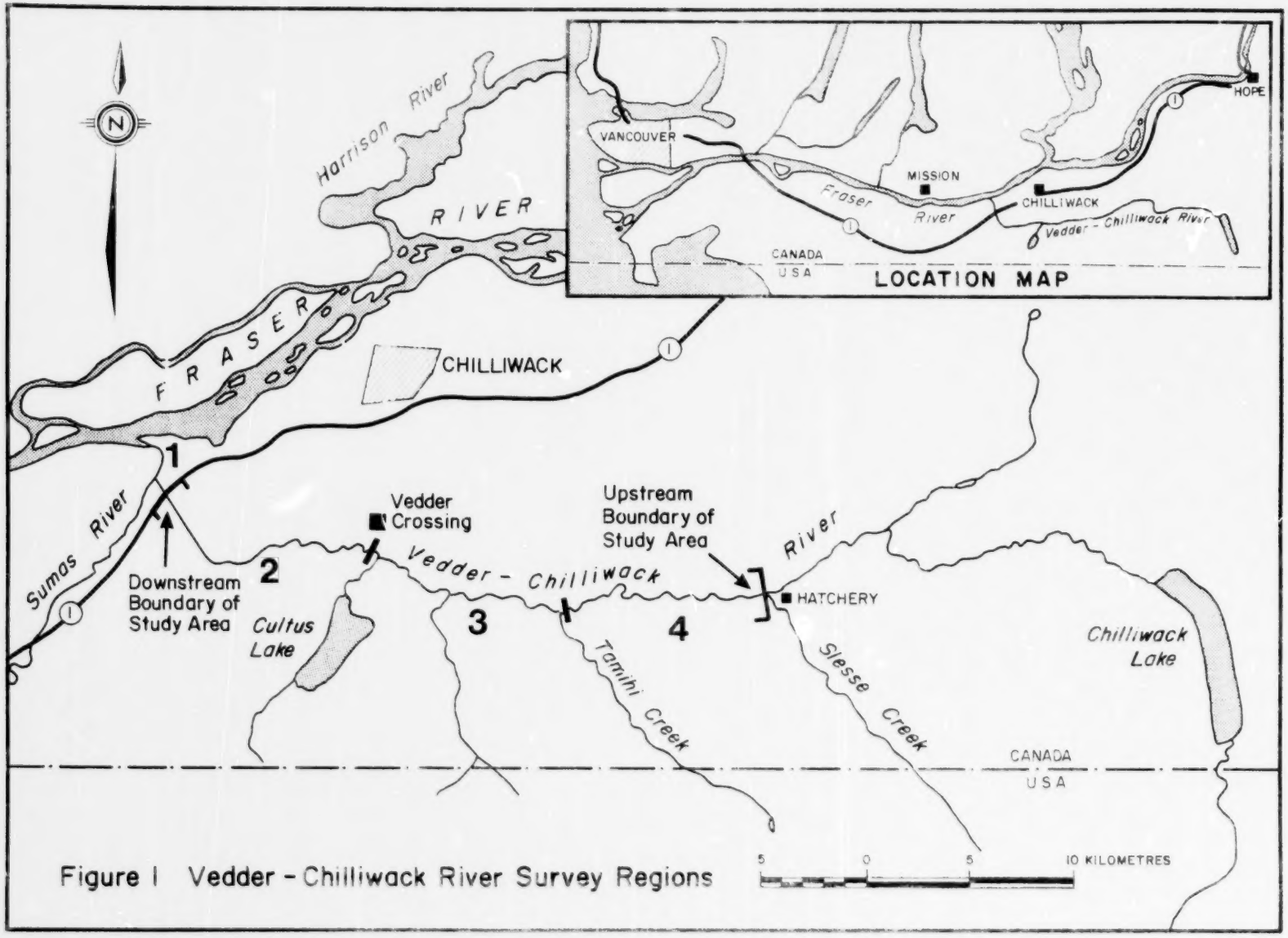

Figure 1 Vedder - Chilliwack River Survey Regions

Lake was permanently closed to all angling to protect wild steelhead trout.

METHODS

STUDY DESIGN

The 1986 Vedder-Chilliwack River sport fishery was assessed, using a roving creel study design (Malvestuto **et al.** 1978), between September 1, 1986 and January 31, 1987. The design involved monthly assessment periods, stratified into weekday and weekend/holiday day types. The sampling schedule included all weekend/holiday days and three weekdays per week. A single surveyor worked one of two randomly selected eight hour shifts encompassing all daylight hours, with actual times adjusted each month to reflect decreasing day length. Data were recorded by region of angler encounter; however, for the purpose of analysis, all data were pooled.

On each sampling day, the surveyor travelled a predetermined route by automobile with a randomly selected start point and direction of travel. Anglers were approached on foot and interviewed regarding the length of time angling (to time of interview and additional expected time, to the nearest half hour), target species, number and species of fish harvested, number of steelhead released, identifying marks on harvested fish (adipose, pelvic or maxillary clip) and gear type. When possible, the harvest was inspected to confirm species and mark identification. An interview form was completed for each angler; however, if the angler was unresponsive or if response reliability was questionable, the form was voided. The sampling day consisted of three periods of two hours in which angler interviews were conducted in each of regions 2, 3 and 4. An additional one and one half hour "instantaneous" rod count of the entire study area was conducted each day within the peak effort period (0900h to 1500h). No interviews were conducted during the rod count. In Region 1 only, effort was estimated from angler counts conducted from a Cessna 172 aircraft. These counts numbered ten in both September and October, six in November and two in December. Effort was not assessed in January, and CPUE was not assessed in any month.

DATA ANALYSES

Angler Effort

Regions 2 - 4: Profiles of hourly angler effort were generated for each month/day-type stratum from angler interview data. Effort data were treated in two ways prior to analysis. First, hourly effort was weighted to compensate for the sampling imbalance which resulted from overlapping survey shifts. Second, on days with heavy effort (greater than 2,000 angler hours), it was not possible to interview all encountered anglers. Since interview data on these days would tend to underestimate midday effort (i.e. the effort profile would be biased towards the tails of the curves), these days were excluded from analysis.

Total sample day angler effort (hours) was determined by dividing the rod count by the proportion of total daily effort which occurred during the rod count time block. Mean daily angler effort (and its variance) was calculated for each stratum. Stratum totals were the product of the mean daily angler effort and the number of days in each stratum. Total monthly and study period angler effort and associated variances were produced by combining stratum totals and variances. The mathematical relationships, based on Mendenhall **et al.** (1971), were as follows:

1) Mean daily angler effort (e) in hours:

$$\bar{e} = [\sum_{i=1}^{n}(c_i/p)]/n$$

where: c_i = rod count at hour x on day i,
p = proportion of total daily effort in hour x,
n = number of sample days in the stratum.

2) Total stratum effort (E), variance (VAR(E)) and 95% confidence limits (CL), all in hours:

$$E = \bar{e}\,N$$

$$VAR(E) = N^2(s^2/n)(fpc)$$

$$CL = \pm\, t\sqrt{N^2(s^2/n)(fpc)}$$

where: $\bar{e}$ = mean daily angler effort (hrs) for stratum,
N = total number of days in stratum.
t = "t" value at 95% level and n-1 degrees of freedom,
n = number of days sampled,
s^2 = sample variance,
fpc = finite population correction.

3) Total monthly or study period angler effort (E_{st}), variance $VAR(E_{st})$, and 95% confidence limits (CL_{st}), all in hours:

$$E_{st} = \sum_{i=1}^{L}(\bar{e}_i N_i)$$

$$VAR(E_{st}) = \sum_{i=1}^{L}[(N_i^2)(s_i^2/n_i)(fpc_i)]$$

$$CL_{st} = \pm t\sqrt{\sum_{i=1}^{L}[(N_i^2)(s_i^2/n_i)(fpc_i)]}$$

where: L = total number of strata,
$\bar{e}_i$ = mean daily angler effort (hrs) for stratum i,
N_i = number of days in stratum i,
t = "t" value at 95% level and n-1 degrees of freedom,
s_i = sample variance for stratum i,
n_i = number of sample days in stratum i,
fpc_i = finite population correction for stratum i.

Region 1: Angler effort in Region 1 was estimated by applying the region 2-4 effort profiles to the overflight angler counts. Variances were not calculated due to uncertainty in the assumption that effort profiles in the two areas were similar.

Catch Per Unit Effort

CPUE in regions 2-4 was calculated by species and mark group for each stratum using a weighted mean of ratios estimator (Malvestuto 1983). CPUE was calculated for each sample day, both for harvested (HPUE) and released (RPUE) fish. Mean CPUE and variance, weighted by effort, was then calculated for each stratum as follows:

4) Mean CPUE ($\overline{CPUE}$), weighted sample variance (s^2), and variance of mean CPUE ($VAR(\overline{CPUE})$), all in fish per hour:

$$\overline{CPUE} = (\sum_{i=1}^{n} w_i CPUE_i)/(\sum_{i=1}^{n} w_i)$$

$$s^2 = [\sum_{i=1}^{n} w_i(CPUE_i - \overline{CPUE})^2]/\sum_{i=1}^{n} w_i$$

$$VAR(\overline{CPUE}) = (s^2/n)(fpc)$$

where: n = number of days sampled,
w_i = weighting factor (total angler effort on day i),
$CPUE_i$ = CPUE on day i.

Catch

Total catch (harvest and release) in regions 2-4, estimated by species/

mark group for each stratum, was the product of stratum effort and the corresponding value of HPUE or RPUE. These estimates were summed to produce monthly and study period harvest and release estimates. Catch and associated variance and confidence limits were calculated as follows:

5) Total stratum catch (C), variance of catch (VAR(C)), and 95% confidence limits (CL):

$$C = (E)(\overline{CPUE})$$

$$VAR(C) = (E)(VAR(\overline{CPUE})) + (CPUE)(VAR(E)) + (VAR(E))(VAR(\overline{CPUE}))$$

$$CL = \pm t\sqrt{VAR(C)}$$

6) Total monthly or study period catch (C_{st}), variance ($VAR(C_{st})$), and 95% confidence limits (CL_{st}):

$$C_{st} = \sum_{i=1}^{L} (E_i \overline{CPUE}_i)$$

$$VAR(C_{st}) = \sum_{i=1}^{L} VAR(C)_i$$

$$CL_{st} = \pm t\sqrt{\sum_{i=1}^{L} VAR(C)_i}$$

where: L = number of strata.

Harvest Rate

Annual harvest rates were calculated for each species/mark group by dividing the estimated harvest by the sum of the estimated harvest and observed escapement. Escapement included both returns to the Chilliwack River Hatchery and escapement to Vedder-Chilliwack system spawning areas.

Awareness Factor

Awareness factor was defined as the ratio of the number of heads recovered from designated depots and the study estimate of the harvest of adipose clipped fish. Awareness factors were calculated for each species. Because age was unknown for those heads from which tags were not recovered (no pin or lost pin), the jack to adult ratio was estimated from the sample from which tags were recovered.

Angler Characteristics

The following angler attributes were summarized by stratum: mean angler day length (hours) for all anglers; mean angler day length by weather type (clear, overcast and rain); mean angler day length for complete and incomplete trips; number of anglers targeting on each species; and preferred gear type. Reported data were not weighted by effort levels.

RESULTS

SURVEY EFFORT

A total of 4,219 angler interviews were conducted between September 1, 1986 and January 31, 1987, with 557 in September, 1,326 in October, 1,123 in November, 471 in December and 742 in January (Appendix 1). The study period included 103 weekdays and 49 weekend/holiday days, of which 47% and 78%, respectively, were sampled. Monthly survey coverage ranged from 29% (December) to 63% (November) of the weekdays and from 40% (December) to 100% (September and October) of the weekend/holiday days.

ANGLER EFFORT

Daily Angler Effort Profiles

Angling occurred between 0400 h and 2100 h, with over 95% of angler

Table 1. Estimated angler effort (hours) by month and region in the Vedder-Chilliwack River, September 1, 1986 to January 31, 1987.

Region	September	October	November	December	January	Total
Region 2 - 4	12,470	46,439	33,493	19,426	30,633	142,461
Region 1	7,581	11,501	3,647	1,182	N/A	23,911
Total	20,051	57,940	37,140	20,608	30,633	166,372

effort occurring between 0500 h and 1600 h (Appendix 2). Angler effort peaked between 0700 h and 1200 h.

Monthly Angler Effort

Regions 2 - 4: Angler effort in regions 2, 3 and 4 totalled approximately 142,500 angler hours (Table 1), with 95% confidence limits of ± 10.2% (Appendix 3). Effort by month totalled 12,500 in September, 46,400 in October, 33,500 in November, 19,400 in December and 30,600 in January. Mean daily weekday and weekend/holiday effort peaked in October at 1,145 and 2,361 angler hours, respectively. Average weekday angler effort was approximately one-half that of the average weekend/holiday day; however, 51% of the total study period effort occurred on weekdays (Appendix 3).

Region 1: Angler effort in Region 1 was estimated at 23,900 angler hours (Table 1), bringing the estimated total angler effort for the study area to 166,400 angler hours. Effort in Region 1 also peaked in October, but declined sharply afterwards (Fig. 2).

CATCH PER UNIT EFFORT

Harvest

HPUE of coho (0.1862) and chinook (0.0035) adults peaked on November weekends while HPUE for coho (0.0099) and chinook (0.0117) jacks peaked on September weekdays (Appendix 4). HPUE of steelhead trout peaked on January weekends (0.0250). Other harvested fish included rainbow trout, cutthroat trout, and Dolly Varden char (**Salvelinus malma**).

Release

RPUE of steelhead trout peaked at 0.0364 on January weekdays. Release data were not recorded for other species.

HARVEST

Coho Salmon

The harvest of coho salmon in regions 2-4 was estimated at 15,279 (14,699 adults and 580 jacks)(Table 2). The monthly harvest of coho adults and jacks peaked at 6,989 and 350, respectively, in October (Fig. 3).

Table 2. Estimated catch by species and month in the Vedder-Chilliwack River (regions 2 - 4), September 1, 1986 to January 31, 1987 (95% confidence limits in parentheses).

	September		October		November		December		January		Total	
A. Harvested Fish:												
Coho	16	(90)	681	(1,095)	692	(1,173)	396	(576)	85	(324)	1,869	(1,703)
Coho (AD)	0	90)	43	(273)	75	(380)	15	(115)	0	-	133	(472)
Coho (AD RP)	37	(234)	63	(332)	287	(690)	0	-	0	-	387	(785)
Coho (RP)	880	(1,029)	6,202	(3,295)	4,802	(3,051)	403	(580)	24	(191)	12,310	(4,554)
Coho Jack	65	(313)	350	(780)	151	(561)	0	-	0	-	566	(990)
Coho Jack (AD)	0	-	0	-	14	(151)	0	-	0	-	14	(148)
Chinook	0	-	131	(478)	115	(470)	0	-	0	-	246	(657)
Chinook Jack	84	(344)	68	(347)	0	-	0	-	0	-	152	(479)
Dolly Varden	16	(990)	12	(148)	0	-	0	-	0	-	28	(170)
Rainbow	18	-	0	-	0	-	0	-	0	-	18	(93)
Steelhead (AD)	0	-	0	-	8	(130)	183	(398)	701	(966)	892	(1,032)
Steelhead (ADLM)	0	-	0	-	0	-	52	(212)	0	-	52	(208)
Steelhead (ADRM)	0	-	0	-	0	-	17	(123)	0	-	17	(102)
B. Released Fish:												
Steelhead	0	-	0	-	0	-	145	(228)	1,003	(1,330)	1,148	(1,350)

The harvest of 12,310 right pelvic clipped coho adults represented 83.8% of the coho adult harvest and 96.0% of marked coho adult harvest. Adipose clipped coho adults numbered 133 (1.0% of marked adults); coho adults with both adipose and right pelvic clips numbered 387 (3.0% of marked adults). The harvest of marked coho jacks numbered only 14 fish, or 2.4% of the jack harvest.

Marked coho adults comprised 98.3%, 90.3%, 88.2%, 51.4% and 22.0% of the monthly coho adult catch between September and January. Marked coho jacks were observed in November only, when they represented 8.5% of the total coho jack harvest.

Over the entire study period, the ratio of observed (examined) to estimated coho harvest averaged 8.2% and 7.1% for adults and jacks, respectively (Appendix 5).

Chinook Salmon

The harvest of chinook salmon was estimated at 398 (246 adults and 152 jacks)(Table 2). The maximum monthly harvest of chinook adults (131) occurred in October; the maximum monthly harvest of chinook jacks (84) occurred in September. No marked chinook (adults or jacks) were observed during the study.

Other Species

The harvest of steelhead trout was estimated at 961 (all of hatchery origin), with 73% of the harvest occurring during January. Minor har-

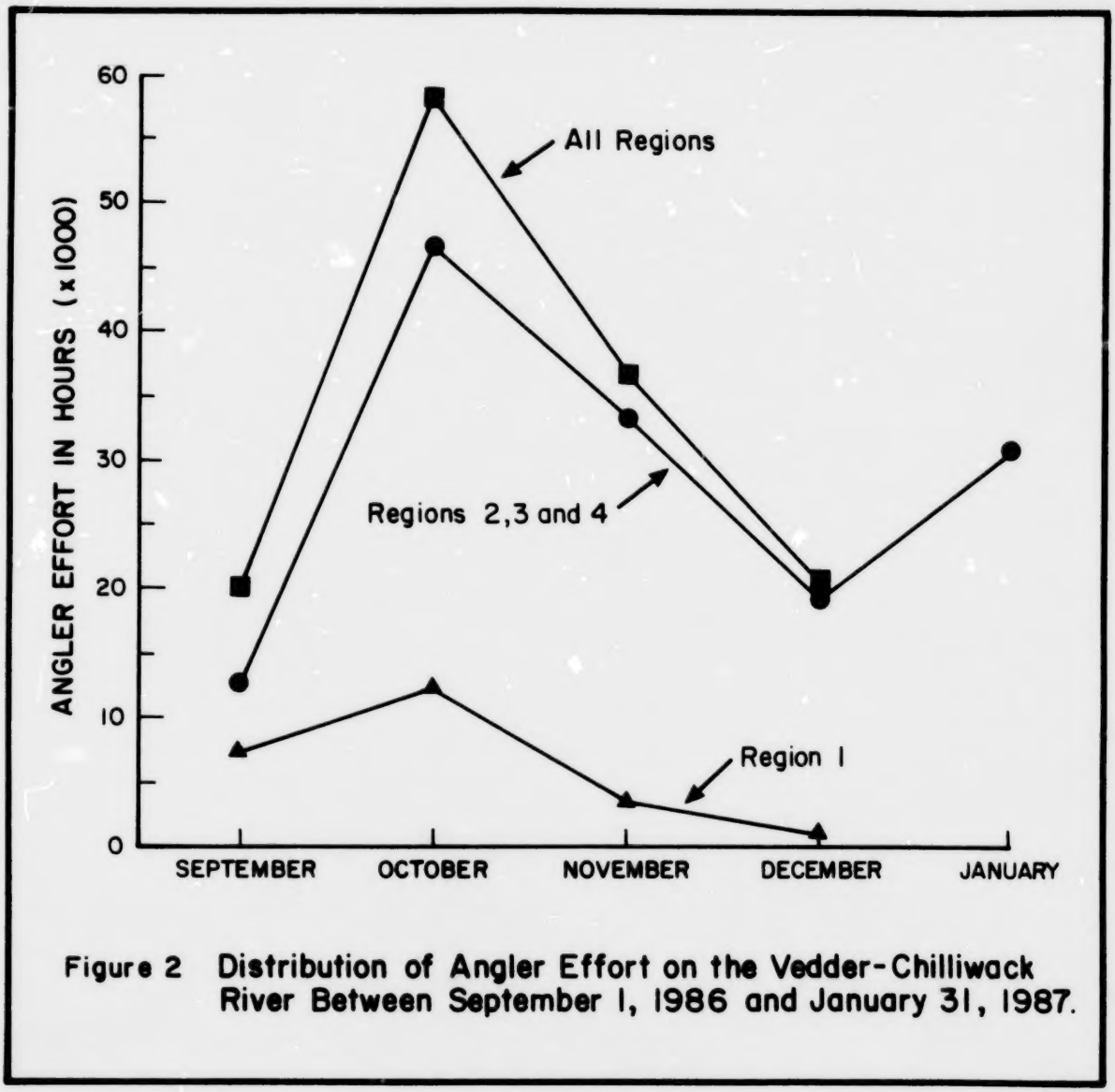

Figure 2 Distribution of Angler Effort on the Vedder-Chilliwack River Between September 1, 1986 and January 31, 1987.

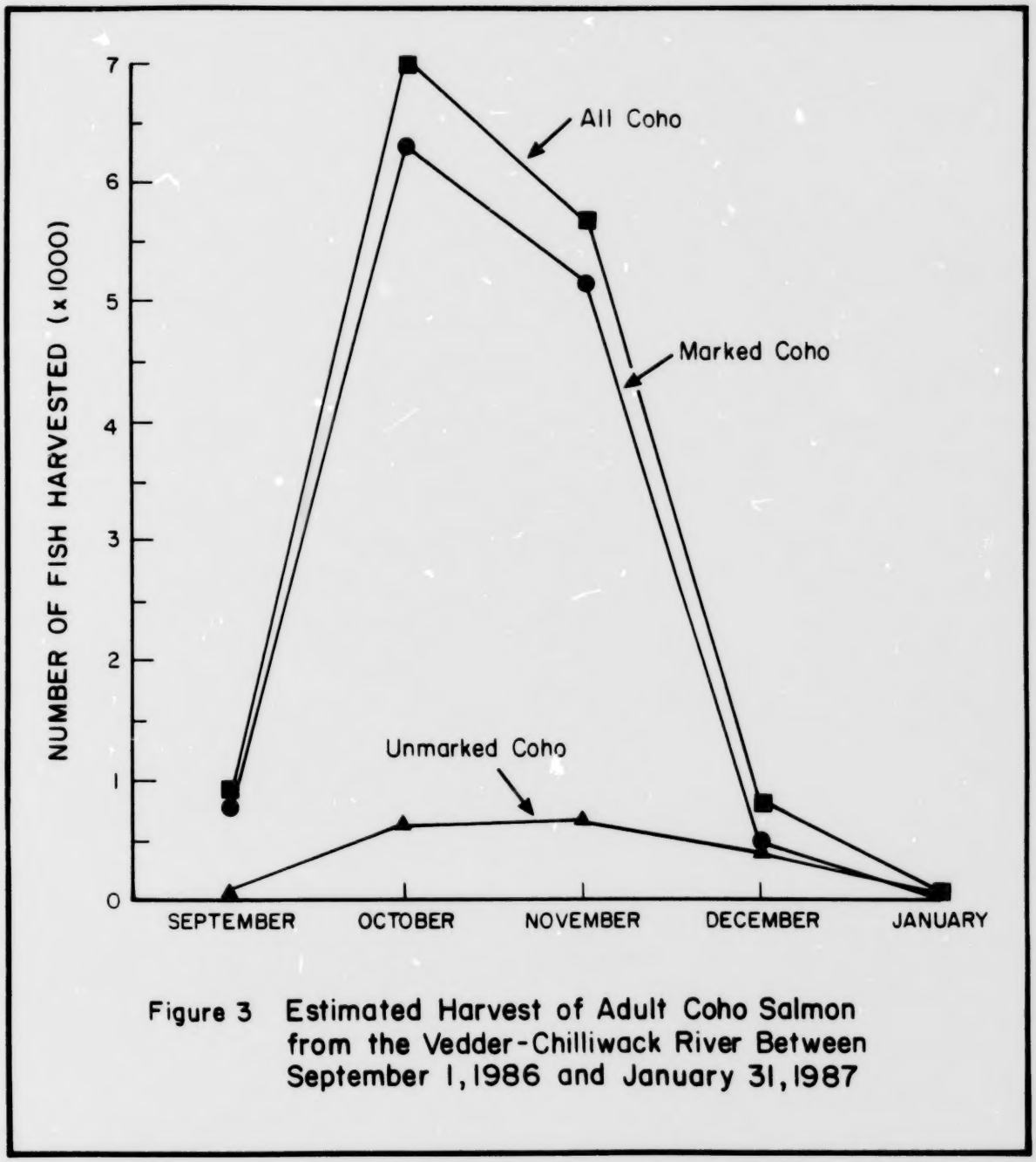

Figure 3 Estimated Harvest of Adult Coho Salmon from the Vedder-Chilliwack River Between September 1, 1986 and January 31, 1987

Table 3. Estimated 1986 harvest rates and awareness factors for Vedder-Chilliwack River coho and chinook salmon.

	Sport Harvest	Escapement			Harvest Rate (%)	Heads Returned	Awareness Factor
		Natural[a]	Hatchery	Total			
Coho	1,869	23,328	3,501	26,829	6.5		
Coho (AD)	133	10	914	924	12.6	94	0.181
Coho (ADRP)	387	10	850	860	31.0		
Coho (RP)	12,310	822	77,742	78,564	13.6		
Coho Jack (AD)	14	-	527	527	2.6	3	0.214
Chinook	246	3,425	101	3,526	6.5		
Chinook (AD)	0	10	10	20	0.0	2	-
Chinook Jack (AD)	0	-	20	20	0.0	2	-

[a] Adults only

vests of rainbow trout (18) and Dolly Varden char (28) also occurred.

RELEASE

An estimated 1,148 steelhead trout were released, with 87% of the release occurring in January (Table 2).

HARVEST RATE

The overall harvest rate for coho adults was estimated at 12.1%. Unmarked coho adults were harvested at 6.5%, while adipose, right pelvic and adipose/right pelvic clipped fish were harvested at rates of 12.6%, 13.6% and 31.0%, respectively (Table 3). The harvest rate for adipose clipped coho jacks was estimated at 2.6%.

Unmarked chinook adults were harvested at 6.5%. Marked chinook (adults or jacks) were not observed during the study period.

Unmarked coho and chinook jacks were not enumerated in the spawning escapement; therefore, harvest rates were not calculated.

AWARENESS FACTOR

Awareness factors for coho adults and jacks were estimated at 0.181 and 0.214, respectively (Table 3). An awareness factor of 0.465 was calculated for steelhead trout (November and December only).

ANGLER CHARACTERISTICS

Average Angler Day Length

Angler day length averaged 4.38 hours for all anglers interviewed during the study period (Table 4). Wea-

Table 4. Summary by month of angler day length, preferred species and gear in the Vedder-Chilliwack River sport fishery, September 1, 1986 to January 31, 1987.

	September	October	November	December	January	Total
Mean angler day (hrs):						
- All anglers	3.51	4.52	4.43	4.28	4.54	4.38
- Incomplete trip	3.71	4.63	4.52	4.43	4.41	4.45
- Complete trip	2.49	3.20	3.69	2.76	3.07	3.17
Target species (% of effort):						
- Steelhead	0.0	0.0	0.0	57.0	97.8	28.8
- Any salmon or trout	98.8	100.0	100.0	43.0	2.2	71.1
- Rainbow	1.2	0.0	0.0	0.0	0.0	0.1
Gear (% of effort):						
- Bait	82.8	98.0	95.4	87.7	72.9	89.3
- Bait and lure	0.2	0.4	0.8	4.4	16.0	4.4
- Fly	1.7	0.0	0.2	0.0	0.0	0.2
- Lure	15.3	1.6	3.6	7.9	11.1	6.2

ther had very little influence on the average angler day length (Appendix 6); however, a difference in average angler day length was noted between complete and incomplete trip interviews. Only 11.8% (496) of the anglers interviewed had ceased angling for the day at the time of the interview. These anglers reported fishing an average of 3.17 hours. The remaining anglers (3,723), who were interviewed during their trip, estimated they would fish for an average of 4.45 hours.

Target Species

Anglers reported their target species as steelhead trout (28.8%) or "any salmon or trout" (71.1%)(Table 4). Steelhead were the preferred species of 57.0% and 97.8% of the anglers in December and January, respectively.

Gear Type

Baited hook was the most commonly used gear (89.3%), followed by lures (6.2%), baited lures (4.4%) and flies (0.2%) (Table 4).

DISCUSSION

OVERVIEW OF THE 1986 FALL FISHERY

Coho Salmon

In 1983, the total production of nine Strait of Georgia and lower Fraser River coho hatcheries was approximately doubled to provide improved sport fishing opportunities for visitors to a world exposition

Table 5. Comparison of Vedder-Chilliwack River sport fishery characteristics between 1985 and 1986.

	1985[a]	1986	Change from 1985
Coho adults:[b]			
- angler effort (hrs)	55,986	111,828	+55,842
- return to the river (no.)	39,050	121,767	+82,717
- harvest (no.)	2,133	14,590	+12,457
- harvest per unit effort	0.0381	0.1305	+0.0924
- harvest rate (%)	5.5	12.0	+6.5
- awareness factor	0.422	0.181	-0.241
- catchability coefficient	1.0×10^{-6}	1.1×10^{-6}	$+0.1 \times 10^{-6}$
Chinook adults:[c]			
- angler effort (hrs)	46,703	92,402	+45,699
- return to the river (no.)	1,110	3,792	+2,682
- harvest (no.)	92	246	+154
- harvest per unit effort	0.0020	0.0027	+0.0007
- harvest rate (%)	8.3	6.5	-1.8
- catchability coefficient	1.8×10^{-6}	0.7×10^{-6}	-1.1×10^{-6}
Angler day length (hrs)	5.05	4.38	-0.67

[a] From Hickey **et al.** (1987)
[b] September through December only
[c] September through November only

held in Vancouver in 1986. Most of these fish were marked with a pelvic fin clip to provide fishery managers the option of "mark only" fisheries. The Chilliwack River Hatchery increased the production of 1983 brood coho smolts to 2.2 million, an increase of 1.6 million smolts from 1982. This level has been maintained since that time. The 1986 return, therefore, was the first year of substantially increased abundance of coho adults in the Vedder-Chilliwack River.

Results from the 1986 and 1985 sport fishery assessment studies for the period September through December are compared in Table 5. Angler effort, and the abundance, harvest and harvest rate of coho adults all increased substantially in 1986. Abundance tripled to 121,800; angler effort, which showed a similar monthly pattern over the two years, doubled to 111,800 hours; harvest increased sevenfold to 14,600; and the harvest rate on coho adults doubled to 12%. As well, the proportion of anglers who had retained one or more salmon (to time of interview) increased from 0.135 in 1985 to 0.212 in 1986, with retention peaking on October weekdays at 0.203 in 1985 and 0.367 in 1986 (Appendix 7). These retention data are intended to show relative annual change only. Because a roving surveyor will contact the average angler near the midpoint of the fishing trip, the actual retention of salmon for full trips was considerably higher than reported above.

The observed increase in harvest rate can be attributed primarily to increased coho abundance and fishing effort. Catchability coefficients, which relate harvest to abundance and effort, increased marginally from 1.0 x 10^{-6} in 1985 to 1.1 x 10^{-6} in 1986 (Table 5); however, a decline in catchability resulting from the dramatic increase in coho abundance and angler effort might have been expected for at least two reasons. First, the more experienced anglers were likely to achieve their desired catch more frequently and in less time than in 1985. This was consistent with both the increase in the proportion of anglers retaining salmon and the decrease in the average angler day length from 5.05 hours to 4.38 hours. Second, the large increase in coho abundance may have attracted less avid anglers to the fishery. Such anglers would likely fish for shorter periods and have a lower success rate than experienced anglers. The decline in awareness factor from 0.422 in 1985 to 0.181 in 1986 suggests that the proportion of anglers unaware of fisheries related projects did increase in 1986. The impact of these factors, however, may have been masked by underestimation of the escapement in 1986 relative to 1985 (discussed later). If that occurred, then the 1986 harvest rate and catchability were overestimated.

Chinook Salmon

The harvest of chinook adults increased by a factor of 2.7, from 92 in 1985 to 246 in 1986. While harvest increased over the two years, the catchability coefficient declined from 1.8 x 10^{-6} to 0.7 x 10^{-6}. This decline may reflect a decline in the number of anglers targeting on chinook, variability in the accuracy of escapement estimation, or a reluctance by the anglers to forego the opportunity to fill the daily catch quota with coho salmon by harvesting white fleshed chinook. Unfortunately, the information needed to confirm these hypotheses was unavailable.

HARVEST RATE

As noted by Hickey **et al.** (1987), harvest rate estimates in the Vedder-Chilliwack sport fishery were subject to a number of biases which related primarily to differences in the techniques used to assess return to the hatchery rack and to the natural spawning areas. For example, the natural spawning areas were surveyed using visual techniques which tend to underestimate adult escapement and which cannot effectively estimate jack escapement. As well, harvest rates estimated from small samples were likely to be inaccurate.

The species-specific impact of the above factors was discussed by Hickey **et al.** (1987) and, while most also applied in 1986, at least one additional factor may influence between year comparisons. The observed return of coho adults to the hatchery rack increased from approximately 22,200 in 1985 to 83,000 in 1986. As a result of increased processing time, there was a tendency for fish to stack up, probably increasing the incidence of straying among hatchery coho. Because escapement to the natural spawning areas was likely underestimated, the harvest rate of these fish may have been overestimated relative to 1985.

AWARENESS FACTOR

The 1986 awareness factor for coho adults harvested in the Vedder-Chilliwack River sport fishery was estimated at 0.181 (Table 5). This represents a substantial decline from the awareness factor of 0.422 reported in 1985 (Hickey **et al.** 1987). The decline in awareness factor may be attributable to two sources. First, as noted earlier, the large return of coho adults may have attracted a larger proportion of inexperienced

anglers who were unaware of the head recovery program. Second, anglers may have been confused by the large return of pelvic fin clipped adults and assumed that the Head Recovery Program did not apply in 1986.

Awareness factors are also reported for coho jacks; however, due to the small sample size, these estimates are considered unreliable.

ESTIMATION OF EFFORT

Angler effort was estimated using an effort profile technique similar to that described by Hickey **et al.** (1987); however, in 1986, two analytic changes were made. First, the profile was stratified into half hour increments to improve precision. Second, in calculation of confidence limits, the finite population correction factor (fpc) was based on available sample hours rather than days in an attempt to more accurately reflect the proportion of the effort actually sampled. As a result, the sampling fraction was smaller and the confidence limits for both effort and catch were larger than those reported by the 1985 study.

ESTIMATION OF CATCH

Unlike the 1985 study, a total ratio estimator could not be used to calculate CPUE because effort was not sampled proportionately each day. During the 1986 study, daily angler effort increased to such a large extent over 1985 that it was no longer possible to interview all anglers encountered. The use of a total ratio estimator under such circumstances would under-represent CPUE information from high effort days. Instead, mean daily CPUE's weighted to estimated daily angler effort were used in the calculation of catch. Confidence limits for catch were calculated using a weighted variance of daily CPUE. The fpc was not used because the sampling fraction based on the proportion of anglers surveyed could not be determined since the total number of anglers was unknown.

SUMMARY

1. The fall coho salmon sport fishery in the Vedder-Chilliwack River was assessed, using a roving creel study design, between September 1, 1986 and January 31, 1987. Angler effort was estimated both above (regions 2-4) and below (Region 1) Highway 1; catch was estimated above Highway 1 only.

2. A single surveyor, working 48 weekdays and 38 weekend/holiday days, recorded the following during 4,219 angler interviews: length of time angling, target species, number and species of fish harvested, number of steelhead trout released, identifying marks on harvested fish, and gear type.

3. Angler effort was estimated by an effort profile methodology in which instantaneous rod counts were converted to estimates of total daily angler effort using profiles constructed from interview data.

4. Study period angler effort in regions 2-4 totalled 142,500 angler hours, with 95% confidence limits of ±10.2%. An additional 23,900 angler hours occurred in Region 1. Between September and December, angler effort almost doubled relative to 1985.

5. Study period harvest totalled 15,279 coho (14,699 adults and 580 jacks), 398 chinook (246 adults and 152 jacks), 28 Dolly Varden char, 18 rainbow trout and 961 steelhead trout. The 1986 harvest of coho adults increased sevenfold over 1985.

6. Marked fish comprised 87.3% of the 1986 harvest of coho salmon adults. Adipose clipped fish comprised 1.0% and 2.4% of the adult and jack harvests, respectively. Right pelvic fin clipped fish accounted for 83.8% of the adult harvest; combined adipose/right pelvic clipped fish comprised 3.0% of the adult harvest.

7. The 1986 overall harvest rate of coho adults in the Vedder-Chilliwack River sport fishery was 12.1%. The harvest rate for marked adults and jacks as 13.8% and 2.6%, respectively.

8. The awareness factor for adipose (includes combined adipose/pelvic) clipped coho adults was 0.181. A significant drop in the awareness factor from 1985 was attributed to a large increase in novice anglers unaware of the Head Recovery Program, and to confusion arising from the large number of pelvic fin clipped coho.

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APPENDICES

Appendix 1. Vedder-Chilliwack River sport fishery survey effort, September 1, 1986 to January 31, 1987.

	September	October	November	December	January	Total
Shifts worked:						
Weekdays -	9	13	12	6	8	48
Weekends -	9	9	10	4	6	38
Days in month:						
Weekdays -	21	22	19	21	21	103
Weekends -	9	9	11	10	10	49
Percentage of days worked:						
Weekdays -	42.8	59.1	63.1	28.6	38.1	46.6
Weekends -	100.0	100.0	90.9	40.0	60.0	77.6
No. of angler interviews:						
Weekdays -	279	650	532	239	375	2075
Weekends -	278	676	591	232	367	2144
Total -	557	1326	1123	471	742	4219

Appendix 2. Angler effort profiles for the Vedder-Chilliwack River sport fishery, September 1, 1986 to January 31, 1987.

	Proportions of total daily effort by hour									
	September		October		November		December		January	
Hour	Wkdy	Wknd	Wkdy	Wknd	Wkdy	Wknd	Wkdy	Wknd	Wkdy	Wknd
0400-0459	0.013	0.005	-	0.001	-	-	-	-	-	-
0500-0559	0.043	0.036	0.021	0.015	-	-	-	-	-	-
0600-0659	0.075	0.080	0.071	0.061	0.003	0.001	-	-	0.003	0.006
0700-0759	0.092	0.094	0.094	0.082	0.053	0.102	0.081	0.050	0.082	0.093
0800-0859	0.108	0.099	0.110	0.083	0.084	0.131	0.130	0.090	0.125	0.131
0900-0959	0.100	0.087	0.107	0.086	0.102	0.135	0.160	0.139	0.144	0.149
1000-1059	0.097	0.076	0.112	0.091	0.106	0.139	0.159	0.137	0.150	0.145
1100-1159	0.093	0.071	0.118	0.100	0.110	0.131	0.155	0.136	0.139	0.142
1200-1259	0.083	0.064	0.102	0.103	0.104	0.117	0.125	0.131	0.129	0.113
1300-1359	0.065	0.084	0.080	0.099	0.096	0.091	0.093	0.117	0.103	0.091
1400-1459	0.062	0.081	0.070	0.096	0.087	0.068	0.057	0.101	0.071	0.068
1500-1559	0.059	0.072	0.059	0.084	0.077	0.047	0.029	0.073	0.041	0.045
1600-1659	0.056	0.062	0.043	0.055	0.063	0.027	0.010	0.022	0.010	0.016
1700-1759	0.037	0.067	0.012	0.031	0.046	0.004	0.001	-	0.003	0.002
1800-1859	0.015	0.019	-	0.012	0.032	-	-	-	-	-
1900-1959	0.001	0.003	-	-	-	-	-	-	-	-
2000-2059	-	0.001	-	-	-	-	-	-	-	-

Note: All times expressed as Pacific Standard Time.

Appendix 3. Estimated angler effort (hours) in the Vedder-Chilliwack River sport fishery, September 1, 1986 to January 31, 1987 (95% confidence limits in parentheses).

	Regions 2 - 4		Region 1	All Regions
	Mean Daily Effort (hrs)	Estimated Total Effort (hrs)	Estimated Total Effort (hrs)	Estimated Total Effort (hrs)
September:				
Weekdays -	312	6,544 (3,128)	4,116	10,660
Weekends -	638	5,926 (1,721)	3,465	9,391
All days -		12,470 (3,570)	7,581	20,051
October:				
Weekdays -	1,145	25,190 (6,679)	5,984	31,174
Weekends -	2,361	21,249 (5,832)	5,517	26,766
All days -		46,439 (8,869)	11,501	57,940
November:				
Weekdays -	789	14,991 (4,957)	2,052	17,043
Weekends -	1,682	18,502 (6,276)	1,595	20,097
All days -		33,493 (7,997)	3,647	37,140
December:				
Weekdays -	445	9,341 (2,757)	672	10,013
Weekends -	1,009	10,085 (2,981)	510	10,595
All days -		19,426 (4,061)	1,182	20,608
January:				
Weekdays -	771	16,193 (4,316)	N/A	N/A
Weekends -	1,444	14,440 (4,653)	N/A	N/A
All days -		30,633 (6,347)	N/A	N/A
Study Period:				
All days -		142,461 (14,563)	23,911	166,372

Appendix 4. Estimated harvest and release per angler hour in the Vedder-Chilliwack River sport fishery, September 1, 1986 to January 31, 1987.

	September		October		November		December		January	
	Wkdy	Wknd	Wkdy	Wknd	Wkdy	Wknd	Wkdy	Wknd	Wkdy	Wknd
A. Harvest Per Unit Effort (HPUE):										
Coho	-	0.00271	0.01790	0.01083	0.01326	0.02665	0.02795	0.01335	0.00398	0.00140
Coho (AD)	-	-	0.00061	0.00130	0.00196	0.00244	-	0.00150	-	-
Coho (AD RP)	0.00558	-	0.00167	0.00099	0.01916	-	-	-	-	-
Coho (RP)	0.09401	0.04460	0.15302	0.11045	0.12649	0.15707	0.02857	0.01348	-	0.00168
Coho Jack	0.00991	-	0.00662	0.00863	0.00095	0.00739	-	-	-	-
Coho Jack (AD)	-	-	-	-	0.00093	-	-	-	-	-
Chinook	-	-	0.00291	0.00271	0.00336	0.00351	-	-	-	-
Chinook Jack	0.01165	0.00127	0.00230	0.00049	-	-	-	-	-	-
Dolly Varden	-	0.00271	0.00049	-	-	-	-	-	-	-
Rainbow	-	0.00300	-	-	-	-	-	-	-	-
Steelhead (AD)	-	-	-	-	-	0.00043	0.00296	0.01536	0.02101	0.02499
Steelhead (ADLM)	-	-	-	-	-	-	-	0.00512	-	-
Steelhead (ADRM)	-	-	-	-	-	-	-	0.00171	-	-
B. Release Per Unit Effort (RPUE):										
Steelhead	-	-	-	-	-	-	0.00983	0.00528	0.03639	0.02864

Note: Units are fish per hour.
AD = Adipose fin clipped.
RP = Right Pelvic fin clipped.
LM = Left maxillary clipped.
RM = Right maxillary clipped.

Appendix 5. Observed and estimated harvests of coho salmon from the Vedder-Chilliwack River, September 1, 1986 to January 31, 1987.

	Sep	Oct	Nov	Dec	Jan	Total
Coho Adults:						
- observed harvest	57	539	556	48	5	1,205
- estimated total harvest	933	6,989	5,856	814	109	14,701
- percentage observed	6.1	7.7	9.5	5.9	4.6	8.2
Coho Jacks:						
- observed harvest	1	28	12	0	0	41
- estimated total harvest	65	350	165	0	0	580
- percentage observed	1.5	8.0	7.3	-	-	7.1

Appendix 6. Angler Characteristics in the Vedder-Chilliwack River sport fishery, September 1, 1986 to January 31, 1987.

	September		October		November		December		January	
	Wkdy	Wknd	Wkdy	Wknd	Wkdy	Wknd	Wkdy	Wknd	Wkdy	Wknd
No. Interviews:	279	278	650	676	532	591	239	232	375	367
Mean angler-day (hrs):										
- All anglers	3.42	3.61	4.72	4.33	4.32	4.54	4.01	4.56	4.63	4.45
- Clear days	3.34	3.54	4.41	4.31	4.35	4.25	4.07	4.24	4.12	4.13
- Overcast days	2.73	3.83	6.06	-	5.04	2.46	3.69	-	-	-
- Rain days	3.58	3.62	4.60	4.39	3.81	4.48	3.90	4.86	4.09	4.90
- Snow days	-	-	-	-	4.68	4.09	-	-	-	4.26
- Incomplete trip	3.64	3.79	4.93	4.36	4.38	4.65	4.17	4.70	4.27	4.56
- Complete trip	2.34	2.66	3.47	2.88	3.68	3.69	2.40	3.15	2.80	3.39
- No. incomplete	231	232	551	594	489	526	219	213	335	333
- No. complete	48	46	99	82	43	65	20	19	40	34
Target species:										
- Coho	0	0	0	0	0	0	0	0	0	0
- Steelhead	0	0	0	0	0	0	121	146	365	361
- Rainbow	3	4	0	0	0	0	0	0	0	0
- Any salmon or trout	276	274	650	676	532	591	118	86	10	6
Gear:										
- Bait	233	228	644	654	507	564	201	211	248	295
- Bait and lure	1	0	1	6	9	2	13	8	61	57
- Fly	3	7	0	0	1	0	0	0	0	0
- Lure	42	43	5	16	15	25	25	13	65	15

Appendix 7. Retention of coho and chinook salmon, to time of interview, by anglers in the Vedder-Chilliwack River, 1985 and 1986.

Year	Month	Day type	Number of anglers interviewed	Number of salmon retained a					Percent of anglers retaining salmon
				0	1	2	3	4	
1985	September	Weekday	71	68	2	1	0	0	4.2
		Weekend	180	164	10	4	1	1	8.9
	October	Weekday	400	319	58	19	4	0	20.3
		Weekend	623	545	46	21	9	2	12.5
	November	Weekday	286	231	40	12	3	0	19.2
		Weekend	463	397	49	13	4	0	14.3
	December	Weekday	109	105	4	0	0	0	3.7
		Weekend	206	193	12	1	0	0	6.3
	Total	Number	2,338	2,022	221	71	21	3	13.5
		(%)	-	86.5	9.5	3.0	0.9	0.1	-
1986	September	Weekday	333	313	15	4	0	1	6.0
		Weekend	248	241	4	3	0	0	2.8
	October	Weekday	147	93	29	13	9	3	36.7
		Weekend	411	313	63	27	5	1	23.8
	November	Weekday	532	379	88	51	10	4	28.8
		Weekend	591	379	119	61	27	5	35.9
	December	Weekday	239	216	17	5	1	0	9.6
		Weekend	232	219	9	2	2	0	5.6
	Total	Number	2,733	2,153	346	166	54	14	21.2
		(%)	-	78.8	12.7	6.1	2.0	0.5	-

a. To time of interview only; retention for full angler days would be considerably higher.